SUMMARY

An area-based research approach to energy transition

The subject of this thesis is the transition of the energy system in its context. While at first glance energy transition is a technical and financial challenge focused on investments in innovative low carbon technologies and initiatives that increase energy saving and renewable energy production, the actual challenge of pursuing a sustainable energy system is multifaceted. Energy transition is a complex and often long-term transformation process. It not only concerns innovation of the energy system, but also innovation in many other sectors and domains, such as agriculture, the economy, community and government. To actually contribute to energy transition, low carbon innovation needs to be linked to communities, economies, ecosystems, infrastructure and governance systems. Initiatives with innovative practices that create and activate links with multiple systems and scales in their spatial contexts can engender co-adaptive and co-evolutionary innovation processes starting from the bottom-up. To improve our interpretation of such transition phenomena, this thesis set itself the following research objective:

To develop an area-based research approach as the starting point for a study of energy transition and use this approach to interpret the contribution of local energy initiatives to energy transition.

An area-based perspective on energy transition may provide new explanations for certain transition phenomena, such as the spreading and upscaling of sustainable innovations, which are not yet well understood. Often, research on societal transitions is based on rather recent theoretical perspectives. In the literature on societal transitions various concept have limited empirical support. Geographers have indicated that a geographic perspective may provide explanations for certain transition phenomena. To fill this research gap, this study adds an area-based approach to transitions research. While transitions research focuses on dynamic and temporal processes, the area-based approach is not dynamic, but does create a bridge to the dynamics of transition. Thereby, this study contributes to literature on societal transitions, both with empirically supported arguments and theory development.

In Chapter 3, this research interprets the shifting relationship between energy and space in the generation of energy landscapes within a time frame of centuries. In Chapters 2, 3 and 4, it interprets the presence of transition phenomena in an energy landscape by analysing snapshots of local energy initiatives in a specific context and at one moment in time. In Chapter 5, it interprets the occurrence of co-adaptation over a few years. In particular, the focus of this thesis is on the area-specific links of local energy initiatives; that is, on how

initiatives interact with their area in physical, socioeconomic and institutional senses at one moment in time.

The area-based research approach developed for this study integrates research domains from spatial planning (area-based planning) and transitions research (complex systems; multilevel perspective on innovation) into one theoretical framework, and makes use of a conceptual model focused on local energy initiatives, area-based niches and the notion of the energy landscape. The three key concepts of this thesis are nested parts: the 'local energy initiative' in the 'area-based niche' as part of the 'energy landscape'. The benefits of studying three nested concepts and the interdependence between them is that it provides in-depth insight into the spatial implications of transition phenomena on several scales.

The research approach stimulated the development of an innovative research method: mapping artefact-actor networks onto graphic representations of energy landscapes. Mapping both actors and artefacts onto the energy landscape generated an informative image of *who* and *what* is related to – and affected by a change in – the energy system and *how* and *where*. By contrast, social network analysis – a commonly used method in the social sciences – would only have retrieved information on *who* is linked, not about the *what* (the artefacts), or about the *how* (the systems and scales, of which the linked actors and artefacts make up a part), or about the *where* (the locations of initiatives, actors and artefacts). The artefact-actor network mapping improved the ability to interpret how initiatives contribute to energy transition. For example, we gained insight into how one initiative was linked to the solar PV panels on a barn roof and to the energy supply of the surrounding community members.

The contribution of local energy initiatives to energy transition

The findings showed that the links of niche initiatives with their contexts create new interaction pathways between the systems and scales of the energy landscape. An interaction path implies that actors and artefacts of various physical and social systems and scales are linked, enabling information to be exchanged across the energy landscape. The interaction paths enable low carbon practices to percolate and penetrate into the energy landscape. Chapter 4 found that the initiatives created new interaction paths in the energy landscape within and across the six systems, and within and across the four scales. These new interaction pathways are potential starting points of co-evolution. Without such interaction pathways, no co-evolution is possible in the energy landscape. In this research, the identification of new interaction pathways forms a bridge between the a-temporal analysis of area-specific links and the interpretation of starting points for co-evolution. In future research, the co-evolutionary processes could be analysed with the help of a longitudinal study; for example, by analysing the impact of new interaction pathways on the energy landscape over several years.

The empirical research findings of this thesis demonstrate four ways in which local energy initiatives change the energy landscape and, by doing so, contribute to energy transition. The findings show that the area-based niche practices of initiatives create new interaction paths in the energy landscape which contribute to: (1) integration of low carbon innovation in the energy landscape, (2) the spreading and upscaling of low carbon innovation, (3) starting points of co-evolution and (4) adaptation of energy policy to area-based niche practices. Furthermore, the empirical research findings contribute to the interpretation of concepts that are used in transitions research: niche innovation, niche mainstreaming, systems co-evolution and system transition. The research findings of this thesis illustrate the contextual conditions under which these phenomena can occur.

Implications for spatial planning and public policy

There are three reasons why the findings of this thesis are valuable for spatial planners and policymakers who aim to pursue energy transition. Firstly, the findings inform the design of spatial plans and policies that aim to stimulate the spreading and upscaling of area-based energy practices. Chapter 4 showed that for innovative technologies and initiatives to spread and upscale, they need to be embedded in society and linked to various human and natural processes in the landscape. The research provides an argument for energy transition policies to stimulate system interaction starting from the local scale in order to engender co-evolutionary processes and energy transition. To promote new system interactions, the research suggests that more integrated and area-based approaches to energy transition policy would be beneficial. For example, energy transition policy goals could be better intertwined with the sustainability goals of other policy fields. A focus on system interaction would improve the effectiveness of energy transition policy.

Secondly, the findings inform the design of spatial plans and policies that anticipate the changing relationship between energy and space due to the uptake of renewables and the rapid rise of local energy initiatives. In Chapter 3, the findings of the desk research into historical and emerging energy transitions highlighted that a shift in the energy system changes the interaction paths within contextual systems, such as the biophysical environment (land uses), the economy (socioeconomic relationships) and the governance system (e.g. community, market or state oriented), affecting the predominance of the local scale in the performance of the energy system in relation to contextual systems. These findings illustrate that the design of area-based plans and policies should allow for adaptation to shifts in the interdependences between energy and space. In the context of energy use and production, spatial plans and policies could allow for changes in, for example, land use (e.g. mixed land use that include solar PV panels), socioeconomic relationships (e.g. community resource exchange) and governance approaches (e.g. local

self-governance). Policies that allow for such changes can help to foster innovative area-based low carbon practices and, by doing so, stimulate energy transition.

Thirdly, the findings of Chapter 5 showed that monitoring and ongoing learning from innovative energy practices can inform policy innovation that supports energy transition. Observing the developments in Dutch energy practice over the years of this research project, several developments became apparent that could well be supported by spatial plans and policy. The initiatives were creating institutional networks that supported new initiatives to become viable and that helped to mainstream area-based energy practices. Often, these institutional contributions to low carbon innovation remain unnoticed in policy reports and only the relatively small contributions of local energy initiatives to energy transition in terms of kWh and MW are mentioned. However, this thesis argued that the development of institutional networks that support the use of new interaction pathways is paramount for mainstreaming low carbon energy practices. This requires more adaptive planning and policy approaches that are able to adapt to contextual changes (flexibility) while remaining a coherent whole (robustness). Approaches that are both flexible and robust can support innovative energy practices to become viable, as Chapter 2 showed, and this will be beneficial to energy transition. Thus, the challenge for spatial planners and policymakers is to monitor upcoming trends and learn from innovative practices, and thereby be able to support promising transition pathways with spatial plans and policies. It is in such an energy transition process that the energy system evolves, with the governance system co-evolving alongside.

A promising direction in which innovative practices, spatial planning and public policy may co-evolve can be seen in the following. The institutional networks that initiatives are developing start to show some area-based institutional capacity to accommodate renewable energy based on common grounds. These area-based institutional networks enhance citizens' agency with respect to energy as common good and can contribute to regional resilience. Nevertheless, to guide a region towards resilience for the long term, the informal structures of area-based institutional networks may need support from democratic institutional structures in order to legitimise area-based energy governance.

The Dutch Water Authorities serve as a good example, as they are democratically chosen, area-based government bodies charged with managing waterways and climate change adaptation in their regions, among other tasks, and they operate in close cooperation with various actors. As in this case of water, the energy issue requires long-term attention and sensitivity. It requires a community of experts who can manage and monitor the energy landscape and operate in close cooperation with the various actors involved. With experimental structures such as 'urban transition labs' and 'urban living labs' legitimacy may be more at risk.

Arguably, energy transition can learn from the experience of the Dutch Water Authorities in dealing with area-based challenges democratically. Area-based institutional structures also represent a decentralised approach to energy transition that can complement the national energy strategy. This decentralised approach explicitly fits with present explorations of what are called 'regional energy strategies' by the Association of Dutch Municipalities, in collaboration with three Ministries, the Dutch Water Authorities and the Association of Dutch Provinces. This exploration has already drawn lessons from successful regions and identified common needs within energy regions. These lessons, and also this thesis, might help to kick-start the institutional design of area-based institutional structures that support the integration of innovative area-based energy practices within the energy landscape and, by doing so, generate integrated energy landscapes.